Atrial late potentials pattern recognition: approaches to classification

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Abstract – **The problem of atrial late potentials (ALP) recognition was solved by the formation of their signs in the basis of eigenvectors. The results of cluster analysis in a model experiment on the classification of electrocardiosignals with and without ALP on the background noise are presented.**

Keywords – **arrhythmia, ECG, atrial late potentials, wavelet transform, eigenvectors, cluster analysis.**

I. INTRODUCTION

The emergence of low-amplitude high-frequency potentials in the terminal part of ECG P wave reflects the presence of slow and fragmented atrial depolarization, associated with the "re-entry" circles and development of atrial tachyarrhythmias. Difficulties of non-invasive registration of ALP are caused by the fact that the amplitude of noise components can greatly exceed the amplitude of ALP.

II. MAIN PART

Numerous simulation experiments revealed that the signs of ALP are contained in the detail coefficients of the first level discrete wavelet decomposition, reflecting the pattern of high-frequency low-amplitude potentials of ECG P-wave. However, the presence of residual noise in real ECG can significantly reduce the reliability of diagnosis, because the noise component and ALP appear at the one level of wavelet decomposition of the analyzed P-wave.

An integrated approach is proposed to identify the low-amplitude high-frequency part of ECG with ALP using wavelet transform and to separate it into diagnostically important signal and noise by decomposition in the basis of eigenvectors. Covariance matrices were formed for ensembles of wavelet detail coefficients obtained by multi-level wavelet decomposition of electrocardiosignals [1].

To find the signs of ALP 46 ensembles were formed, each of which consisted of 10 sets of wavelet detail coefficients. As a result the sets of eigenvalues λ_1, λ_2, ..., λ_N and eigenvectors $\boldsymbol{V} = [\boldsymbol{V}_1, \boldsymbol{V}_2, ..., \boldsymbol{V}_N]$ were obtained for each covariance matrix. Values *L, R, K, S*

$$L = \frac{\lambda_i}{\sum_{k=1}^{N}\lambda_k}\cdot 100\%, \quad R = \frac{\lambda_1}{\sum_{i=1}^{N}\lambda_i}, \quad K = \frac{\sum_{i=2}^{N}\lambda_i}{\sum_{i=1}^{N}\lambda_i}, \quad S = \sum_{i=1}^{N}\lambda_i$$

are used to estimate the proportion of the information contained in the component that is determined by the eigenvector $\boldsymbol{V}_i$. L_1 = 62% for the signal with ALP, i.e. the largest amount of the information about ALP contains in the first principle component (fig.1).

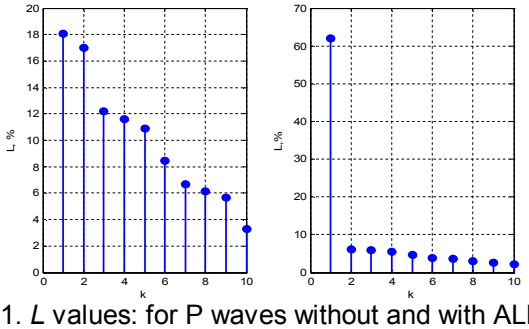

Fig.1. *L* values: for P waves without and with ALP

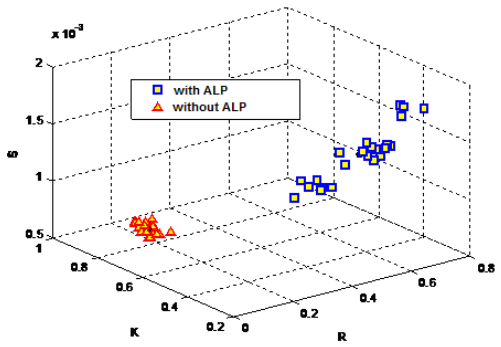

Fig.2.The results of clustering: norm and pathology

Analysis of points groups in three-dimensional feature space *[S, K, R]* indicates the presence of two clusters of data. The cluster with the close packing of points corresponds to data relating to P waves without ALP, representing the class "norm". Large enough, comparing with the first case, the spread of signs within the second cluster, representing the class of "pathology", is caused by the individual character of ALP for each of the patients (fig.2).

III.CONCLUSION

As a result of the proposed method two non-overlapping clusters for classes "norm – ALP absence " and "pathology – ALP presence" were obtained in the feature space.

REFERENCES

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